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FOREST INSECT INVESTIGATIONS

THE MORE COMMON INSECTS ATTACKING YOUNG CONIFEROUS PLANTATIONS
AND NATURAL STANDS ON THE NATIONAL FORESTS OF THE LAKE STATES
AND SUGGESTIONS FOR PREVENTING OR CONTROLLING INJURY

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Within recent years the problem of insect injury to young coniferous plantations and natural stands on the national forests of the Lake States has become serious. For about 10 years observations on insect abundance in these areas have been made annually by the personnel of the various forests and the Division of Forest Insect Investigations. In addition the latter Division, in cooperation with the Forest Service, began an ecological study of these insects in 1941. Although this study was carried on almost entirely on the Manistee National Forest the information gained in 3 years' study is generally applicable to all the forests in the Lake States, even though site and growing conditions may differ in some cases.

A relatively large number of forest insect species has been mentioned in the annual reports and some of them are of economic importance. The object of this report is to discuss the more common species from the standpoint of the appearance of the injury and the stage of the insect causing it, and the possibilities of prevention and control of the injury by direct measures as well as good forest practices.

As an aid to the field man in rapidly determining the cause of injury the following key is suggested:

KEY BASED ON CHARACTER OF THE INJURY AND THE STAGE OF THE INSECT

- | | |
|--|---|
| 1. Foliage affected | 2 |
| Twigs, branches, or entire tree affected | 7 |
| 2. Foliage eaten by defoliating insects | 3 |
| Foliage injured but not eaten | 6 |
| 3. Foliage devoured | 4 |
| Foliage clipped off at base or chewed off as it develops | 5 |

1. Senior Entomologist and Associate Entomologist respectively of the Division of Forest Insect Investigations.

4. Soft bodied "worms", about 1 inch long when full grown; feeding in groups on various species of conifers. SAWFLIES

Jumping insects, feeding singly and often gnawing the tender bark as well as eating the foliage of all conifers. GRASSHOPPERS

5. True caterpillars, in clusters of needles webbed together. Early stages on jack pine in the staminate blossoms; on spruce and fir in the buds. Heavily infested trees assume a brown or "burned" appearance in late June and early July. SPRUCE BUDWORM

Beetles, closely related to the June beetles. Needles of the current season chewed off as they develop. Needle growth late in season is short, giving the trees a ragged appearance. Old foliage eaten when new growth is not available. Only in lower Michigan at present time. Various pines are hosts, with jack pine preferred. PINE CHAFER

6. Needles of jack pine covered with a whitish woolly exorescence, needles often becoming yellowish-green in color. JACK PINE NEEDLE APHID

Twigs of spruce with pineapple-like or cone-like galls on the current year's growth, formed by the enlargement of the basal portions of the needles. SPRUCE GALL APHIDS

7. Tips of leading shoots or laterals killed 8
Branches or trees killed 9

8. Leading shoots killed - usually 2 or more years. New growth wilts from June to early August. Legless, white grubs found between the bark and wood in the early stages working downward in a ring or in the wood and pith in the later stages. Pines and spruces attacked, white pine and jack pine being favored hosts. WHITE-PINE WEEVIL

Tips killed back several inches, small caterpillars in buds and pith of twigs, or in pitch masses on the twig covering the gallery. Several species of pine are attacked. PINE BUD, TIP, OR TWIG MOTHS

9. First indication of injury characterized by yellowing or reddening of the foliage; usually on individual branches but in heavy attacks entire tree may be affected and death occur quickly. Fungus diseases may hasten death. 10

First indication of injury characterized by unhealthy condition of entire tree, foliage being short and yellowish, particularly at tips. 11

10. Surface of wood with minute punctures often surrounded by brown stain and blocked with coagulated resin. Injury caused by jumping insects - adults of spittle bugs feeding from July to September. Nymphs of the more important species do not feed on pines, but at the base of undergrowth such as sweet fern. All species of pine.

SPITTLE BUGS

Injury characterized by a sooty fungus formation on the needles and small twigs. Small brown female scales, tortoise shell in shape, and glistening, empty male pupal cases are conspicuous in the early fall. Jack pine and Scotch pine.

PINE TORTOISE SCALE

11. Inner bark and surface of wood marked with winding galleries; heavy infestations cause girdling of the stem. Saplings and larger trees. Several species of pines.

BARK BEETLES

Root collar or roots attacked

12

12. Root collar with large galleries at surface of wood, and with soil around attacked portion infiltrated with pitch. Legless, white grubs, about a half-inch long when full-grown. Sapling pines attacked, chiefly on sandy sites.

PINE ROOT-COLLAR WEEVIL

Roots of young transplants severed below the ground line. Mostly in plantations in grass land the first and second season after planting.

WHITE GRUBS

SAWFLIES: The most important of the pine sawflies are the red-headed pine sawfly, Neodiprion lecontei (Fitch) and the jack-pine sawfly, N. banksianae Rohwer. The young larvae of the first named species have a brownish head and the body is whitish to light yellow with faint longitudinal markings. As they grow older the head becomes reddish and the body bright yellow with rows of irregular, broken, black markings. When full-grown they are about one inch long. There may be two broods each year, defoliation being noticeable about the middle of July and again in September. The young larvae of the jack pine-sawfly are light green, changing to a darker green with black stripes along the sides as they grow older. The head is jet black. This species has one generation a year, the defoliation being noticeable late in May and in June. The larvae of both species feed in groups; two or more often feed on one needle, devouring it to its base. The foliage of a branch or an entire tree may be completely consumed, most of the defoliation occurring in a few days in the late stages of larval development. At least two other species not determined to species at the present time, have been

found on pines in the Lake States. The adult sawflies of all species do not cause injury to the trees, other than laying the eggs in the needles.

The larch sawfly, Lygaoonematus erichsonii (Htg.), caused heavy mortality of mature larch from 1910 to 1915. In recent years little tree mortality has been reported but many thousands of acres of swamp land have a good growth of young larch and some severe defoliation has been reported. Destructive defoliation by this insect can be expected when the present stands become mature. The larvae, which are dull grayish green in color with conspicuous black heads, feed in groups. The eggs are laid in slits in the young, tender shoots early in June; this causes the shoots to curl and when the insects are abundant this injury is noticeable.

The yellow-headed spruce sawfly, Pikonema alaskensis Rohwer, and an undescribed species of Neodiprion, cause defoliation of the spruces. The larvae of the former are yellowish green with a light orange or brown head, while those of the undescribed species are somewhat similar to the larvae of the jack-pine sawfly. The yellow-headed species feeds during June and July, preferring the new growth. When full-grown and when new growth is not available they will feed on the older needles. The other species feed in groups on the old needles during June and early July.

Control: Conifers growing under the shade and barrier protection of hardwoods are not seriously defoliated by sawfly larvae, although an occasional tree may be attacked. Where individual tree release can be practiced the maximum protection will be obtained. There is evidence that sawfly abundance is periodic. This being the case pure stands, especially those recently established, should be surveyed when a "build-up" in the sawfly population is threatening. Much injury can probably be prevented by early detection and spraying of a few trees. The cost of this can be charged off against the stand as a whole, thereby making the operation financially possible, whereas the cost of spraying all the trees on thousands of acres of plantations prohibits such an operation. Trees should be sprayed, as soon as the small larvae are noticed, with a solution prepared at the rate of 4 pounds of powdered lead arsenate to 100 gallons of water, with 4 ounces, by weight, of linseed oil or fish oil as an adhesive, for each pound of lead arsenate. With the adhesive added this spray solution will give protection for several weeks.

GRASSHOPPERS: During the years when they are numerous grasshoppers do great damage to young, newly planted trees - particularly in grassland the first and second seasons after planting. In heavy infestations the foliage is completely devoured and the tender bark may be gnawed from the stems and small twigs. Older plantations and natural stands are not damaged severely. Grasshoppers are injurious in both nymphal and adult stages.

Control: Damage by grasshoppers can be prevented through the use of poison baits, a number of which have been used and recommended in various parts of the country. Baits containing molasses and banana oil, in order to be effective, must be used within 24 hours after preparation. The following formula, which can be held safely for several days without losing its effectiveness and can, therefore, be prepared in large quantities, was developed on the Manistee and has been successfully used for several years: 100 pounds of bran and sufficient sawdust to make a total weight of 400 pounds (approximately 7 bushels by volume), 1 gallon of sodium arsenite, and 10 to 12 gallons of water. After the carrying agents - bran and sawdust - are well mixed, the sodium arsenite and water should be worked well into the mixture so that each particle has a coating of the poison. This bait should be scattered evenly by hand along the rows - 10 pounds per acre for infestations up to 30 grasshoppers per square yard; 20 pounds per acre when there are more than 30. Care should be taken to protect the hands when preparing and spreading this poison bait. Grasshoppers do not feed well at temperatures below 65° F.; the best time to spread the bait is in the morning as soon as the insects begin to move about actively.

BUDWORM: The spruce budworm, Archips fumiferana (Clem.) attacks a number of conifers throughout the United States and Canada. In the Lake States two forms are present, a host preference being very evident. Although there appear to be no distinguishing characteristics one form is found on the pines, with jack pine preferred, and the other form is found on the spruces and balsam fir, with the latter host preferred. Both forms hibernate as tiny larvae in minute capsules under bark scales and similar places. The young caterpillars on pine are yellowish green, those on fir or spruce are brownish; when mature they are nearly an inch long and are reddish brown to dark brown in color, with light yellow tubercles tipped with hairs. Development of an infestation in a pine stand is dependent on an abundance of staminate (male) flowers, where practically all the young caterpillars feed. Such a condition is commonly found in "orchard" jack pine stands. The budworms migrate to the new foliage, about the time it is well developed. The needles are clipped off at the base and webbed together to form a silken shelter where pupation later takes place. The spruce-fir form develops to serious proportions in those stands where balsam fir predominates. The young caterpillars bore into the buds about the time they are swelling, and as the new growth develops it is eaten. As the foliage develops and the caterpillars become older they clip the needles and spin a loose protective covering of silk and needle particles in which they feed and pupate.

Control: The nature of the larval habits - in the early stages in the flowers or buds and in the later stages in a protective web precludes successful control with ordinary spray mixtures.

Some success has been obtained by spraying with concentrated insecticides at the time of larval migration. At present, however, such concentrated mixtures should be used only by trained technicians. It is expected that great strides will be made in the near future in the development of these new insecticides. Silvicultural practice, designed to reduce the abundance of favored host material in any stand, is the logical approach to prevention of damage by both forms of the budworm found in the Lake States forests. Stands with a high percentage of jack pine should be kept fully stocked but not allowed to stagnate or become overmature, so as to limit the production of an abundance of staminate flowers. In the spruce-fir types the latter species should take up only a minor part of the stand composition. Wherever possible, mixed stands should be developed as studies in the past have shown that the susceptible species in such stands are not seriously defoliated and heavy infestations do not develop.

PINE CHAFER: The pine chafer, Anomala oblivia Horn, has been found only in the lower peninsula of Michigan in the Lake States. It has caused noticeable defoliation since 1935 in jack pine stands in the northern portions of the Manistee, and in some plantations there has been an appreciable reduction in height growth. The adults, which are scarab beetles from one-quarter to one-half inch in length, cause the damage. Their activity extends from early June to the last of July, although the individuals only live about a month. The most serious injury is to the new growth, although when it is destroyed the old foliage will also be attacked. In some cases the needle is eaten as it pushes through the needle sheath, in other cases the needles are partially cut off at the outer end of the sheath, causing them to turn brown and cling to the sheath.

Control measures have not been attempted. No tree mortality has occurred but in some instances death of the upper part of the crown has been observed. As is the case with many forest insects the most severe injury has occurred in pure stands, both natural and planted. Pine growing nearby under hardwood protection was not noticeably injured.

JACK PINE NEEDLE APHID: In 1942 and 1943 a needle aphid, Schizolachnus piniradiatae (David.) was abundant on the foliage of the previous year in jack pine plantations in the northern ranger districts of the Manistee. These insects are found on the slightly concave inner surface of the needles and are covered with a woolly excrescence. In 1942 in one plantation on the Baldwin district large numbers of predaceous insects were found feeding on this insect and the pine tortoise scale. The following season the aphids appeared to be less abundant. The injury to the trees does not appear to be of economic importance except in those areas where jack pine is used for Christmas trees. The yellowish-green cast of the foliage serves to detract from the value of the trees for this purpose.

If a control treatment should be considered necessary in plantations where Christmas trees are harvested the insects can be killed with a contact spray solution of a half-pint of nicotine sulphate in 50 gallons of water in which 2 pounds of soap have been dissolved.

SPRUCE GALL APHIDS: The eastern spruce gall aphid, Chormes abietis L., is not a serious forest insect in the Lake States. It is, however, a pest of ornamentals and trees in windbreaks in nurseries. The injury is characterized by pineapple-like galls at the base of the current season's growth, caused by an enlargement of the basal part of the needles and resulting from the feeding activities of the nymphs. Norway spruce and white spruce are the favored hosts and even in these species only about one-fourth of the trees in a stand are highly susceptible. At least one-third of the trees are completely immune and vigorously growing trees will, in most cases, overcome a heavy attack.

The pine leaf aphid Pineus pinifoliae (Fitch) forms terminal galls on spruce as an alternate host. In some areas these galls are very common on black spruce. When fully developed, they are about one and one-half inches long, compact, and look very much like a true cone. The insects leave the galls the middle of June and migrate to the foliage of pine. After feeding for some time they move to the new growth of the pine where they hibernate.

Control: In the forest control measures are, generally speaking, unnecessary, as the small number of heavily galled trees can be removed and destroyed as they become noticeable. In windbreaks the highly susceptible "breeder" trees should be removed and burned. The loss seriously attacked trees can be protected by spraying in the fall after the eggs have been laid (about October 15) or in the spring before growth and aphid activity have started (about April 15). A contact spray, such as a solution made up of 1 pint of nicotine sulphate, 3 pounds of soap, and 100 gallons of water should give complete control with one thorough application at either of the times mentioned. Special attention should be paid to the tips of the twigs and bases of the buds as these are the places where the overwintering nymphs are found.

WHITE-PINE WEEVIL: The white-pine weevil, Pissodos strobi (Peck), is the most serious insect in plantations and natural stands throughout the Lake States as a region. White pine and jack pine are the favored hosts although other pines and the spruces are also injured. The injury is caused by the larvae - small legless, white grubs that will be a little more than a quarter-inch in length when full-grown. They feed between the bark and the wood, working downward in a ring, and as they become full-grown they make pupal chambers in the wood and pith. A heavily infested leading shoot will be killed in a short time, but there will be every gradation from practically no new

growth to nearly all of it. The tip withers and turns brown and the new growth wilts and bends over. In a relatively large percentage of the vigorous trees that are attacked, only a small number of eggs are laid and the resulting larvae are smothered by the copious resin flow. A few incomplete galleries will be found and there will be a characteristic leakage of resin which hardens on the bark surface. In such cases the only damage is a small loss in height growth, as the tips do not die. The adults hibernate in the litter beneath trees on which they fed during the fall. Activity is resumed in the spring when the buds begin to swell. The eggs are laid, as a rule, in the growth of the preceding season, so that there will be a loss of at least 2 years' growth when the leading shoot dies. Jack pine often loses only the current years' growth as the eggs may be laid in this portion after height growth is well established and there is woody tissue present. The new laterals may not be killed under such circumstances. When a leading shoot is killed there is a loss in height and also in diameter. The timber value is also materially affected as the trees may be of poor form and lumber sawed from them usually shows large knots and crooked boards are common.

Control: The most advantageous and cheapest way to protect a susceptible species and control the injury is to grow it in mixture, preferably with species that will be of value in the final crop. Weedings or releasings in the early stages, if the mixture is with hardwoods, and thinnings as the stand becomes older will be necessary so that the susceptible species will not be crowded out. There will be fewer of these trees in a mature stand than in a pure stand of normal stocking, but those surviving will be clean-barked and straight, and the monetary value of the whole crop will be greater. In fully stocked pure stands the weeviled trees tend to straighten at the point of attack because of competition for height growth and in many cases merchantable stands of good quality can be reclaimed by selecting the best trees and favoring them in the final crop. In widely spaced plantations, 8' x 8' or wider, and in sparsely stocked natural stands most of the injured trees will be forked and have large branches thereby reducing their merchantable value.

Direct measures are generally too expensive, except in isolated stands where the attack is just starting and where there is little chance of re-infestation if complete control is obtained. The weeviled tips can be removed and burned as soon as the wilting is noticeable, care being taken to cut the tips well below the infested portion. Recent investigations in the northeastern states indicate attack can be prevented by using a concentrated spray made up of the following, in parts by weight, lead arsonate 1, water 10, adhesive oil 0.3. This mixture should be applied late in March and during April, using a compressed air sprayer with a special

solid-cone type of nozzle. Trees up to 16 feet in height were sprayed at an average cost of \$2.00 per acre, most of which was for labor. This measure would not be applicable with jack pine, where the eggs are often laid in the growth of the current season.

PINE BUD, TIP, OR TWIG MOTHS: The caterpillars of at least four species of moths cause damage to the various pines, both planted and natural, in the Lake States. These species are: the Nantucket pine tip moth, Rhyacionia frustrana Comst., the European pine shoot moth, R. buoliana (Schiff.), the Zimmerman pine moth, Dioryctria zimmermanni (Grote), and the pitch twig moth, Petrova albicapitana Heinrich. The injury causes death of a bud or twig and a heavily infested tree may be badly deformed, or a branch or entire tree may be killed by repeated attacks.

The Nantucket pine tip moth is a common pest in nurseries and plantations in the southern part of Region 9 but it has caused little serious damage in the Lake States. A few infested tips of leading and lateral shoots have been reported each year from young plantations of both jack pine and red pine in most of the northern forests but in almost every case the trees had been planted in furrows and the tips were under the snow-line during the winter. Infested tips were rare in older trees, giving rise to the belief that sub-zero temperatures, which are common over the area covered by the national forests of the Lake States, caused heavy mortality of the hibernating pupae or full-grown larvae. The first stage of the injury, in the early summer, is characterized by one or two dead needles at the tip of the shoot. Later on, especially when there are several caterpillars, an infested bud may be entirely eaten. Very often the caterpillars bore into the center of the twig and follow down the pith. When the tip dies adventitious buds grow from the living portion immediately below. The caterpillars are yellowish to pale brown and when full-grown are about three-eighths of an inch long.

The European pine shoot moth is not common, except in the southern part of Michigan. When present in the northern area there has been some evidence to show that it was brought in on infested stock. The most important host is red pine although Scotch pine is also a favored host. This insect hibernates as a young caterpillar in the bud. As they are very susceptible to sub-zero temperatures, -18° F. killing all those in exposed tips, it is doubtful if this species will ever become a serious pest in the northern forests. The injury is confined to the buds of the leading and lateral shoots and the developing new growth, with the most serious damage occurring in the spring. The young caterpillars are light brown, becoming dark brown as they grow older. When full-grown they are nearly three-quarters of an inch long.

The Zimmerman pine moth attacks most species of pine and causes two distinct types of injury - one in the tips of the branches and the other in the trunk. Very young trees are not often attacked and the heaviest damage occurs in open-growing trees. The tunneling in the tips causes them to turn brown and break off. This is often noticeable when the infestation is heavy. When the trunk is attacked the point of injury is usually near a node or where an injury has occurred. Where several caterpillars may be working in one area of attack, the stem will be enlarged and there will be pitch leakage. Very often these places will have woodpecker holes, caused by the birds searching for the caterpillars. The caterpillar, which is about three-quarters of an inch long when full grown, varies in color from a dirty white, through reddish yellow to green. Black dots, from each of which arise a single hair, cover the body.

The pitch twig moth is very common on jack pine, although other hard pines are also attacked. The injury appears in the early summer as a pitch mass, hardened on the surface, just below the tips of the leading or lateral shoots. Under this mass will be found a simple gallery, about the size of the pitch mass and from this an entrance hole leads to the pith, down which the caterpillar mines several inches. The caterpillar, which is pale brown in color and about a half-inch long when full-grown, hibernates as a partly developed larva. It resumes feeding and completes development in the spring. The attacked twigs do not often die, although they may often be broken by wind, snow or ice, and they may heal completely.

Control: As a general rule none of these four insects have been sufficiently numerous to warrant control measures. When infested twigs are found, during the course of general plantation inspections, they should be removed and the caterpillars destroyed. This operation is not practical, however, over large plantation areas as a special control measure. Nurseries should be inspected regularly and when trees are found actively infested with the Nan-tucket pine tip moth or the European pine shoot moth they should be removed and the larvae destroyed immediately. In addition the nursery handbook rules should be followed in that all lifted stock should be examined during the grading and all trees suspected of being infested should be destroyed so as to prevent moving the insect to planting areas.

SPITTLE BUGS: From time to time spittle bugs become abundant and heavy mortality may occur in young pine stands. Two species, the pine spittle bug, Aphrophora parallela (Say) and the Saratoga spittle bug, A. saratogensis (Fitch), are common in the Lake States. Until recently all spittle bug injury was attributed to the pine spittle bug - the spittle masses in which the nymphs develop will be found on the twigs of all species of pine during May and June.

The adult bugs also feed on the pines and suck the sap from the twigs during July and August. No serious injury, however, has been reported from the Lake States national forests. The Saratoga spittle bug, on the other hand, has caused heavy branch injury, and tree mortality in many cases, of jack pine and red pine in practically all the forests since 1940 when the attacks first became serious. The nymphs of this species develop on undergrowth, such as sweet fern, so that injury to the pines is caused only by the adults, their feeding activity lasting from July through September. This feeding injury has a double effect on the trees. When the insects are abundant they suck a tremendous amount of sap from the trees, thereby causing a form of starvation. The second effect is a mechanical form of injury, a girdling action resulting from the formation of wound tissue around the feeding punctures and a plugging of the cell structure with coagulated rosin. The injury is usually first noticed the spring following the feeding injury and is characterized by dead tops or red-foliaged branches. When the feeding activity is very pronounced an entire small tree may die during the winter. Test cages have proved that the feeding injury by the adults is sufficient to kill branches. Following the appearance of the red foliage certain fungi have been found in the dead and dying areas in the bark. These fungi have not been fully investigated but it is probable they assist in a more rapid disintegration of the trees. The adult pine spittle bug is a little more than a half-inch long; the general color is dark reddish brown, with two narrow bands usually bordered with darker bands crossing each wing cover obliquely. The Saratoga spittle bug is light tan, with lighter cross markings. It is slightly smaller and narrower across the shoulders than the pine spittle bug.

Control; Studies on the Manistee National Forest give strong indications that serious damage by the Saratoga spittle bug can be prevented by good silvicultural practices. Wherever possible mixed stands should be favored as the underbrush on which the nymphs develop will be crowded out. Pure stands, that have not closed, are more likely to be seriously damaged because the adults are sun-loving insects and in addition it is in such areas that sweet fern and other underbrush flourish. In the case of the pine spittle bug some success has been obtained in other localities by spraying the nymphs with a nicotine-sulphate and soap solution, but over large forested acreages this means of control is usually too costly. The very nature of the habitat for the developing nymphs of the other species - in the litter at the base of the stems of the underbrush - precludes the possibility of attempting this measure of control. Freezing temperatures of 16° F. will kill most of the young nymphs and very hot, dry weather may prevent them from exuding enough spittle to keep them from drying up and dying.

PINE TORTOISE SCALE: This scale insect, Toumeyella numismaticum (P. & M.) is widely distributed and occasionally becomes abundant enough to cause serious mortality in plantations. Such a situation occurred in the northern end of the Manistee National Forest in 1942. Although various hard pines are known to be hosts, jack pine is the only species that has been seriously damaged in plantations or stands on the national forests. The injury results from the sucking activity of the insects and when a tree or branch is dying the foliage is yellowish and the bark and the older needles have a black oily appearance caused by a fungus which grows on the sap excreted by the scales. The females hibernate as immature, dark brown tortoise-shell shaped scales on the bark of the twigs. When the insects are abundant the infested trees or branches have a grayish cast caused by the glistening, silvery, empty male pupal cases in large clusters around the developing female scales. The mature female scales are oval-convex in shape, about one-quarter of an inch long, and reddish-brown in color. There is one generation a year.

Control: Heavily infested branches or trees should be cut and left in the plantation. The scales cannot develop on cut material because the sap supply is cut off, and in addition parasites and predators can develop and may help in controlling infestations on trees that were missed in the cutting operation. Infested ornamentals can be protected against new attack by a dormant spray, such as a miscible oil, in the spring before growth starts.

BARK BEETLES: In the Lake States the species of bark beetles that are found on young conifers are essentially secondary in their action. They can successfully attack trees which have been weakened by fire injury, drought conditions, exposure, defoliation, or some mechanical injury. During the active season bark beetles may be attracted in large numbers to slashings in a logging operation and young trees nearby are often seriously damaged and the less vigorous ones may succumb to concentrated attacks. The two commonest species on young pines are Ips pini (Say) and Pityogenes hopkinsi Swaine. Attacked trees usually have an unhealthy appearance, the needles being yellowish to red depending on the actual condition of the tree and the stage of the attack. In the early stages of attack a few entrance holes, often surrounded by hardened pitch on the bark surface, will be found in the bark. Later, if the bark is removed, the egg-tunnels and larval galleries will be found etching the inner bark and the surface of the wood. Still later there will be an intricate network of larval galleries and when a tree is heavily attacked and girdled it dies. Control, as a rule, is not considered practical because when a tree is in a condition favoring successful attack there is little possibility of saving it. In thinning operations care should be taken not to pile the

cut material against young pine trees as such a procedure usually invites attack. Unhealthy trees should be removed in the course of thinning operations.

PINE ROOT-COLLAR WEEVIL: In the Lake States this weevil, Hylobius radicis Buch., has been found on jack pine, Scotch pine, red pine, and Austrian pine. The soil around the base of an attacked tree is blackened and soaked with pitch and the larvae are found in this material or in the cambium region around the root collar. Late in summer the white, footless larvae, the pupae, and the adults may all be found in the burrows. Pupation often occurs in the tunnels extended out into the pitch-infiltrated soil. Sometimes trees are entirely girdled below the surface of the ground and in such cases the foliage usually becomes yellow and finally the tree dies. Lightly infested trees, which are not girdled, may sustain an infestation for several years without appearing to be particularly unhealthy. There is no practical control in the forest.

WHITE GRUBS: These are the larvae of the family of beetles collectively known as chafer. There are a large number of species in the Lake States but the most important, from the standpoint of injury caused, are members of the genus Phyllophaga - the June beetles. Although some damage is caused by the adults most of it occurs as partial defoliation of deciduous trees. White grubs damage young conifers in nursery beds and in recently planted areas by stripping the bark from the roots or by cutting the roots below the ground level. The greater part of the injury occurs in the nursery beds. In sod areas, under medium cover of aspen, oak, birch, willow, rose, junberry, hazel, etc., heavy damage may occur the first and second season after planting. The grubs are white and vary in size, when full-grown, from one-half inch to more than one inch in length. The beetles of the various species are slightly smaller than the full-grown larvae. The grubs remain in the soil during their larval development, burrowing below the frost line during the winter months. Some species complete their development in two seasons, others in three.

Control: In the forest, control of white grubs should be based on prevention of damage by restriction of planting sites. Generally speaking, areas larger than 10 acres should not be planted if a grub survey shows a concentration of 1 grub of the genus Phyllophaga or 2 of any of the other genera per square foot. When a nursery is known to be infested the population of grubs can usually be effectively decreased in any area to be used for transplant beds by tilling with a rotary tilling machine twice - when the grub season is at the peak, once about the end of June, and again about three weeks later. If the soil is moist and the tilling is done on a hot, bright day the mortality of the exposed injured grubs will be greater.

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In case more detailed information is desired the following partial list of publications is suggested. Most of those publications are to be found in the Journal of Forestry or can be obtained by writing to the publishing agency. The starred publications are available from the Department of Agriculture Library, Room 970, Madison Bldg., 623 North Second Street, Milwaukee 3, Wisconsin, or the Division of Forest Insect Investigations, Room 870, Madison Bldg., 623 North Second Street, Milwaukee 3, Wisconsin. The various Forest Service reports can be obtained from the Division of Timber Management, Regional Office.

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